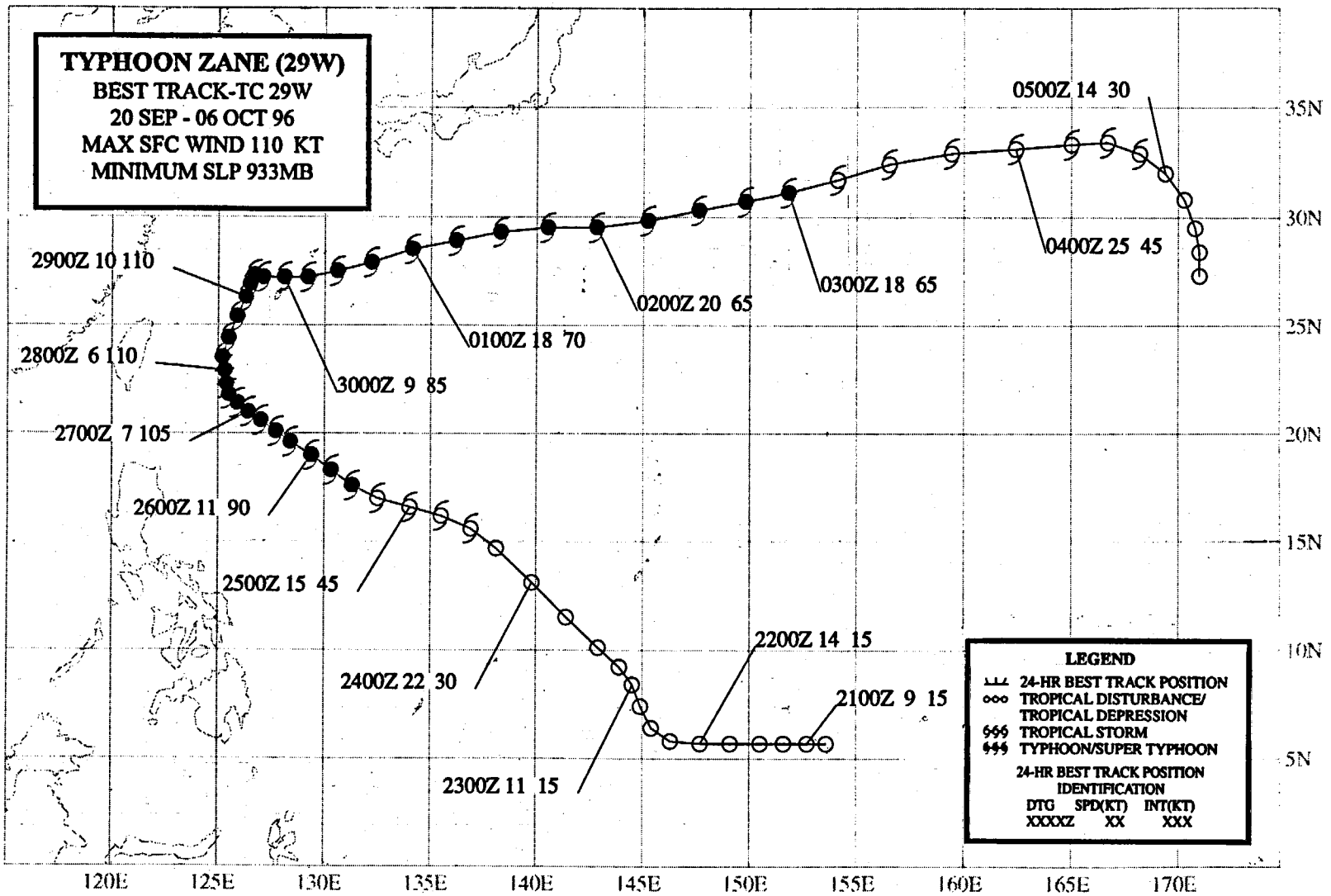
TYPHOON ZANE (29W)
BEST TRACK-TC 29W
20 SEP - 06 OCT 96
MAX SFC WIND 110 KT
MINIMUM SLP 933MB
2900Z 10 110
2800Z 6 110
2700Z 7 105
2600Z 11 90
2500Z 15 45
2400Z 22 30
2300Z 11 15
2200Z 14 15
2100Z 9 15
0500Z 14 30
0400Z 25 45
0300Z 18 65
0200Z 20 65
0100Z 18 70
3000Z 9 85
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/ TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XXX
35N
30N
25N
20N
15N
10N
5N
120E
125E
130E
135E
140E
145E
150E
155E
160E
165E
170E

TYPHOON ZANE (29W)

I. HIGHLIGHTS

Zane and Yates (28W) developed in the same monsoon trough, at approximately the same time, and recurved simultaneously along similarly-shaped and spatially-proximate tracks. The typhoon affected both Taiwan and Okinawa. Passing Okinawa, Zane came within range of Kadena's NEXRAD. After recurvature, Zane maintained its central deep convection despite being embedded in deep-layer westerly flow to the north of the subtropical ridge.

II. TRACK AND INTENSITY

During early September, five TCs — Sally (23W), TS 24W, Tom (25W), Violet (26W), and Willie (27W) — formed in the monsoon trough. This very active monsoon trough moved northward, and became reverse oriented. By the final week of September, it had migrated to a relatively high latitude as TCs Tom (25W) and Violet (26W) carried the trough with them out of the tropics. As this monsoon trough exited the tropics, a new monsoon trough formed at low latitudes, and was the site of development for the next two TCs in the WNP — Yates (28W) and Zane.

While the WNP was still dominated by the reverse-oriented monsoon trough which contained Tom (25W), Violet (26W) and Willie (27W), the low latitudes of the WNP were dominated by high pressure and low-level easterly flow. As Tom (25W) and Violet (26W) recurved, a new monsoon trough formed in Micronesia. Deep convection associated with this monsoon trough consolidated within two areas. The eastern area became Yates (28W) and the western area became Zane. The large area of deep convection which became Zane was larger than the one which became Yates (28W) and is a good example of a monsoon depression (Figure 3-29-1). It was first mentioned on the 201900Z Significant Tropical Weather Advisory. This monsoon depression moved westward and, typical of monsoon depressions, it was several days before deep convection persisted near the low-level circulation center. When the deep convection persisted near the LLCC, a TCFA was issued at 230600Z. A second TCFA was issued at 232030Z in order to reposition the alert box. Based on satellite intensity estimates of 25 kt (13 m/sec), the first warning on Tropical Depression (TD) 29W was issued, valid at 240000Z September. Remarks on this warning included:

". . . Tropical Depression 29W is located in the monsoon trough equatorward of the subtropical ridge. TD 29W is located approximately 800 nm west of Typhoon Yates (28W). Satellite imagery indicates the presence of weak ridging to the southeast of 29W. The rapid north-northwestward movement of TD 29W is associated with the enhanced southerly steering component associated with the weak ridging between TD 29W and Typhoon Yates (28W). . . ."

The rationale for the motion of TD 29W in this remark is a good description of what is known as "indirect TC interaction" in the "Systematic and Integrated Approach". Yates' (28W) summary contains a more complete description of the interaction between Zane and Yates.

During the night of 24 September, deep convection rapidly consolidated over the LLCC of TD 29W and, on the warning valid at 241200Z, TD 29W was upgraded to Tropical Storm Zane. Soon after the formation of Zane's CDO, the peripheral cloudiness in the monsoon depression was suppressed and the areal extent and amount of deep convection became smaller. Moving northwestward, Zane intensified and became a typhoon at 251200Z. The peak intensity of 110 kt (57 m/sec) was reached at 280000Z, which was maintained until 291200Z. During this time, the typhoon moved on a slow northward track and passed approximately 90 nm (170 km) to the west of Okinawa. On 29 September, Zane slowed and made a sharp turn to the east, passing approximately

20 nm (40 km) to the north of the northern end of Okinawa (Figure 3-29-2) and, despite being embedded in westerly flow north of the subtropical ridge maintained typhoon intensity. On 02 October, Zane (still a typhoon) possessed a very unusual cirrus outflow pattern: cirrus debris streamed eastward on both the north and south sides of the system, evoking the analogy of debris being stripped from a comet by the solar wind (Figure 3-29-3a) (see the discussion). On 03 October, westerly shear finally began to have an effect, and the LLCC of Zane became partially exposed on the west side of the deep convection. At 031200Z, the final warning was issued, as Zane began its extratropical transition. After the final warning, the system moved east and then south as it encountered the vigorous outer circulation of the large intense extratropical low which was once Yates (28W) (see Figure 3-28-2 in Yates' (28W) summary).

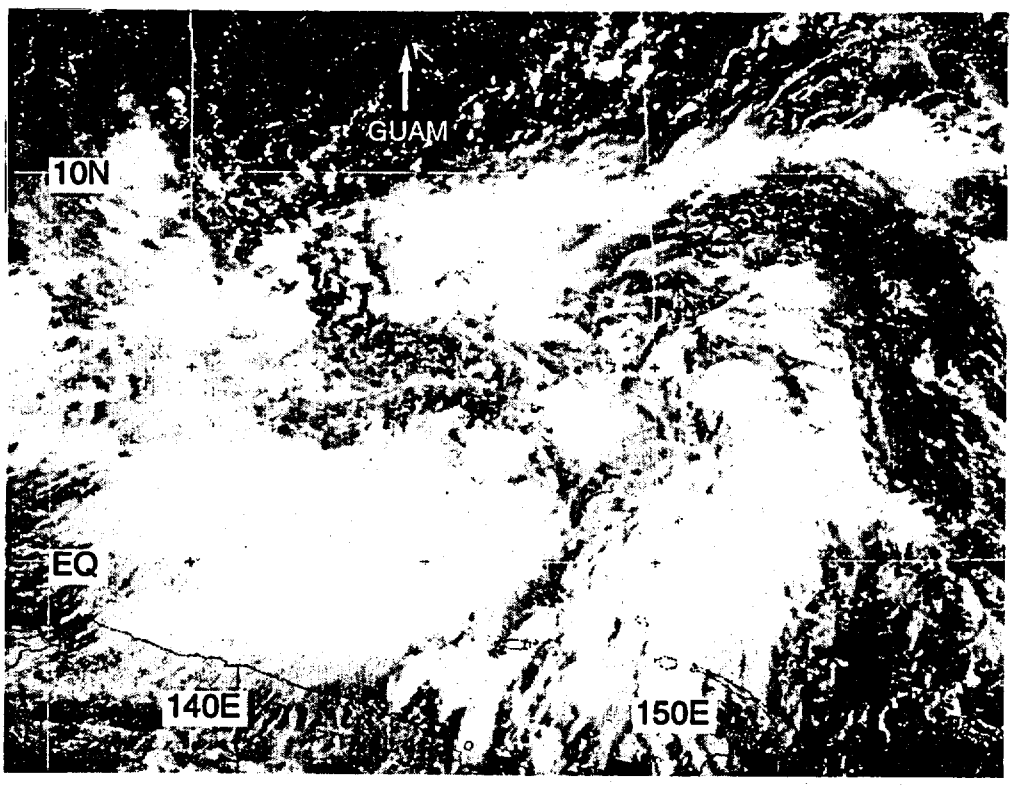

Figure 3-29-1 Zane originated from this monsoon depression located to the south of Guam (212224Z September visible GMS imagery).

III. DISCUSSION

a. *Origin as a monsoon depression south of Guam*

Zane began as a monsoon depression near Guam. Initially it was a large ensemble of mesoscale convective systems embedded within a region of lowered sea-level pressure. It lacked persistent central deep convection, and the maximum winds in the system were displaced outward from the low-level circulation center. Eventually as the system moved toward the northwest, the circulation intensified, and persistent central deep convection became established marking its transition to a conventional TC. Cam's (05W) summary contains a detailed discussion of the structure and evolution of monsoon depressions in the WNP.

b. *Passage within range of Guam's and Kadena's NEXRADs*

When forming near Guam, some of the rainbands (that were part of the monsoon depression which became Zane) came within the range of Guam's NEXRAD. One of the most interesting features of these rainbands was the presence of mesoscale vortices associated with convective cells in these rainbands. These mesovortices were detected by the meso-alert algorithm of the NEXRAD. Mesoscale vortices are often associated with tornadic activity over land, however, tornadic activity (e.g., tornadic waterspouts) have yet to be associated with NEXRAD-observed mesoscale vortices near Guam. They frequently are seen when tornadic activity is occurring in TC rainbands over land in the US mainland.

When Zane passed close to Okinawa, it came within range of the NEXRAD's velocity detection capability. Nothing unusual was noted as the well-defined radar eye of Zane passed. The base velocity product showed maximum inbound and outbound velocities on the order of 115 kt (59 m/sec) at altitudes of approximately 5,000 ft.

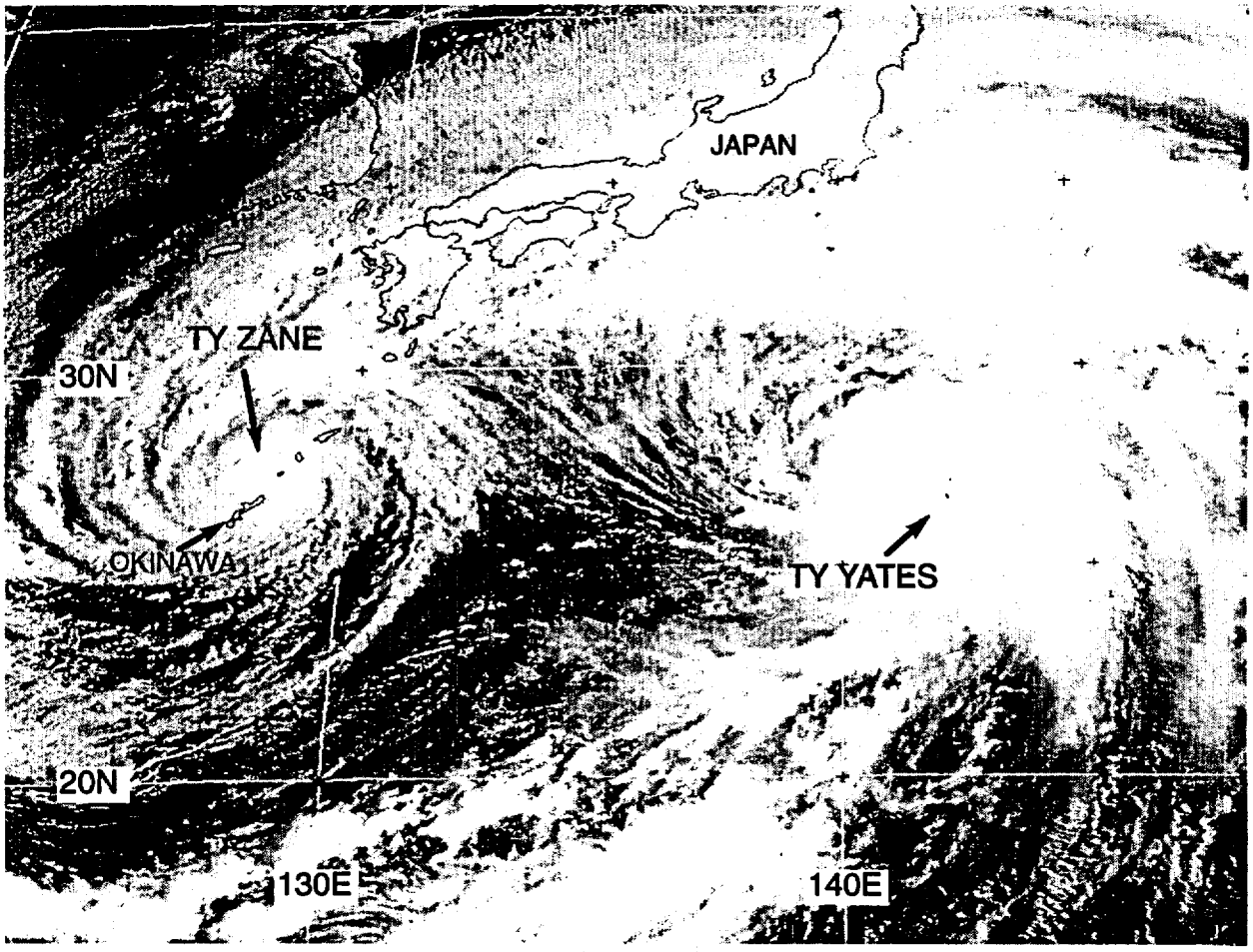

Figure 3-29-2 The rainbands of Zane sweep across Okinawa while at its closest point of approach to that island. Typhoon Yates (28W) is seen approximately 900 nm (1700 km) to the east of Zane (292224Z September visible GMS imagery).

c. *Unusual persistence as a tropical cyclone while embedded in midlatitude westerlies*

On 02 October, Zane (still a typhoon) possessed a very unusual cirrus outflow pattern: cirrus debris streamed eastward on both the north and south sides of the system, evoking the analogy of debris being stripped from a comet by the solar wind (Figure 3-29-3a). Water-vapor derived winds clearly show the upper-level winds to the north and south of Zane were from the west (Figure 3-29-3b). Zane was moving approximately 20 kt (37 km/hr) to the east-northeast at this time, while the azimuthally averaged 200-mb wind (at a radius of 300 nm) around the TC was from the west at approximately 50 kt. One might expect that a TC in such an environment would shear apart. This did not happen to Zane. The maintenance of Zane's CDO under apparent shearing conditions, and the near symmetry of the cirrus outflow within strong westerly winds aloft are unusual phenomena that raise questions about the relationship between the structure of a TC and the vertical shear of the horizontal wind.

IV. IMPACT

No reports of serious damage or injuries in Okinawa were received at the JTWC. About US $50 thousand in damage was reported by US military installations on Okinawa —mostly downed trees and power lines. Another US $118 thousand in damage was reported on the island, mostly to crops. Highest wind gusts reported on Okinawa were 79 kt (41 m/sec) at Kadena AB and 64 kt (33 m/sec) at Naha. Up to 12 inches (307 mm) of rain soaked the island. In Taiwan, heavy rains from Zane triggered mudslides that killed two people.

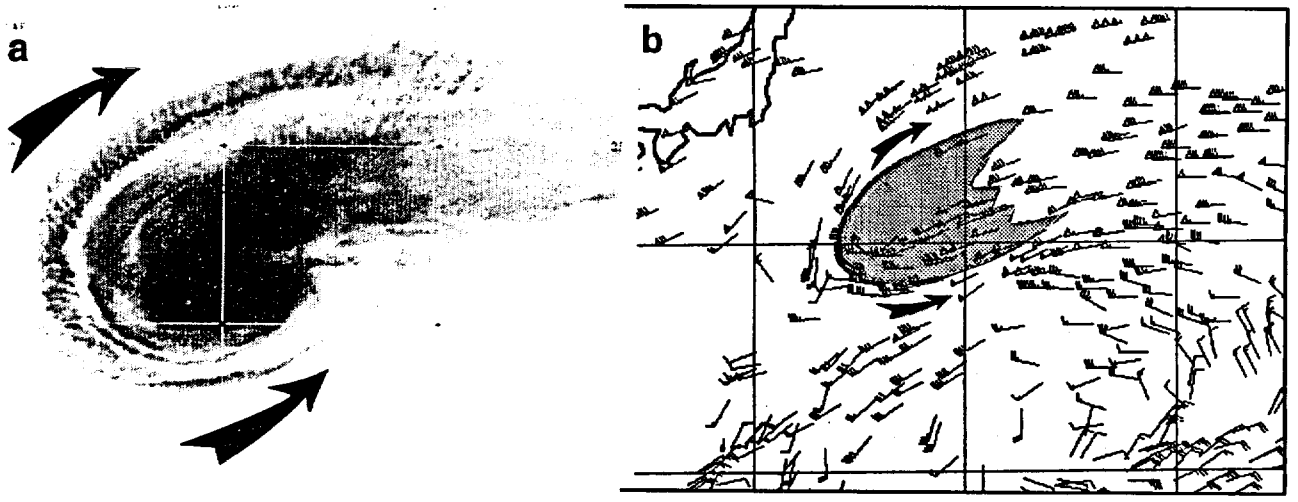

Figure 3-29-3 (a) Cirrus outflow is carried off to the east by strong upper-level westerly winds on both the north and south sides of Zane (021624Z October infrared GMS imagery, inverted-IR enhancement). (b) Water-vapor derived upper-tropospheric winds show Zane (the shaded region) was completely embedded in a westerly airstream. The divergence from the typhoon's convection caused the winds to split and go around the TC (021200Z October water-vapor derived upper-tropospheric winds).